General

Guideline Title

ACR Appropriateness Criteria® right lower quadrant pain — suspected appendicitis.

Bibliographic Source(s)

Smith MP, Katz DS, Rosen MP, Lalani T, Carucci LR, Cash BD, Kim DH, Piorkowski RJ, Small WC, Spottswood SE, Tulchinsky M, Yaghmai V, Yee J, Expert Panel on Gastrointestinal Imaging. ACR Appropriateness CriteriaÂ® right lower quadrant pain--suspected appendicitis. [online publication]. Reston (VA): American College of Radiology (ACR); 2013. 10 p. [74 references]

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Rosen MP, Ding A, Blake MA, Baker ME, Cash BD, Fidler JL, Grant TH, Greene FL, Jones B, Katz DS, Lalani T, Miller FH, Small WC, Spottswood S, Sudakoff GS, Tulchinsky M, Warshauer DM, Yee J, Coley BD, Expert Panel on Gastrointestinal Imaging. ACR Appropriateness Criteria® right lower quadrant pain -- suspected appendicitis. [online publication]. Reston (VA): American College of Radiology (ACR); 2010. 7 p.

Regulatory Alert

FDA Warning/Regulatory Alert

Note from the National Guideline Clearinghouse: This guideline references a drug(s) for which important revised regulatory and/or warning information has been released.

- December 14, 2016 – General anesthetic and sedation drugs : The U.S. Food and Drug Administration (FDA) is warning that repeated or lengthy use of general anesthetic and sedation drugs during surgeries or procedures in children younger than 3 years or in pregnant women during their third trimester may affect the development of children's brains. Consistent with animal studies, recent human studies suggest that a single, relatively short exposure to general anesthetic and sedation drugs in infants or toddlers is unlikely to have negative effects on behavior or learning. However, further research is needed to fully characterize how early life anesthetic exposure affects children's brain development.

Recommendations

Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Right Lower Quadrant Pain—Suspected Appendicitis

Variant 1: Fever, leukocytosis, and classic presentation clinically for appendicitis in adults.

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen and pelvis with contrast	8	Oral or rectal contrast may not be needed depending on institutional preference.	☢☢☢☢
CT abdomen and pelvis without contrast	7	Use of oral or rectal contrast depends on institutional preference.	☢☢☢☢
US abdomen	6	Perform this procedure with graded compression.	O
US pelvis	5	This procedure is appropriate in women with pelvic pain.	O
MRI abdomen and pelvis without and with contrast	5	See statement regarding contrast in text below under "Anticipated Exceptions."	O
X-ray abdomen	4	This procedure may be useful when there is concern for perforation and free air.	☢☢
CT abdomen and pelvis without and with contrast	4	Oral or rectal contrast may not be needed in this procedure depending on institutional preference.	☢☢☢☢
MRI abdomen and pelvis without contrast	4		O
X-ray contrast enema	2		☢☢☢
Tc-99m WBC scan abdomen and pelvis	2		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Fever, leukocytosis; possible appendicitis, atypical presentation, adults and adolescents.

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen and pelvis with contrast	8	Oral or rectal contrast may not be needed depending on institutional preference.	☢☢☢☢
X-ray abdomen	6	This procedure may be useful in excluding free air or obstruction.	☢☢
US abdomen	6	Perform this procedure with graded compression.	O
US pelvis	6	This procedure is appropriate for women with pelvic pain.	O
CT abdomen and pelvis without contrast	6	Use of oral or rectal contrast depends on institutional preference.	☢☢☢☢
MRI abdomen and pelvis without and with contrast	5	See statement regarding contrast in text below under "Anticipated Exceptions."	O
CT abdomen and pelvis without and with contrast	4	Oral or rectal contrast may not be needed depending on institutional preference.	☢☢☢☢
MRI abdomen and pelvis without contrast	4		O
X-ray contrast enema	2	The RRL for the adult procedure is ☢☢☢.	☢☢☢☢
Tc-99m WBC scan abdomen and pelvis	2		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative**

pelvis Radiologic Procedure	Rating	Comments	RRL*
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Fever, leukocytosis, pregnant woman.

Radiologic Procedure	Rating	Comments	RRL*
US abdomen	8	Perform this procedure with graded compression. This procedure is better in the first and early second trimester.	O
MRI abdomen and pelvis without contrast	7	This procedure may be useful following negative or equivocal US.	O
US pelvis	6		O
CT abdomen and pelvis with contrast	5	This procedure may be useful following negative or equivocal US and MRI. Oral or rectal contrast may not be needed depending on institutional preference.	☢☢☢☢
CT abdomen and pelvis without contrast	4	This procedure may be useful following negative or equivocal US and MRI. Use of oral contrast depends on institutional preference.	☢☢☢☢
CT abdomen and pelvis without and with contrast	3		☢☢☢☢
MRI abdomen and pelvis without and with contrast	2		O
X-ray abdomen	2		☢☢
X-ray contrast enema	2		☢☢☢
Tc-99m WBC scan abdomen and pelvis	2		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: Fever, leukocytosis, possible appendicitis, atypical presentation in children (younger than age 14).

Radiologic Procedure	Rating	Comments	RRL*
US abdomen	8	Perform this procedure with graded compression.	O
CT abdomen and pelvis with contrast	7	This procedure may be useful following negative or equivocal US. Oral or rectal contrast may not be needed depending on institutional preference.	☢☢☢☢
X-ray abdomen	6	This procedure may be useful in excluding free air or obstruction.	☢☢
US pelvis	5	This procedure is appropriate in women with pelvic pain.	O
CT abdomen and pelvis without contrast	5	Use of oral contrast depends on institutional preference.	☢☢☢☢
MRI abdomen and pelvis without and with contrast	5	See statement regarding contrast in text below under "Anticipated Exceptions."	O

Radiologic Procedure	Rating	Comments	RRL*
MRI abdomen and pelvis without contrast	4		0
CT abdomen and pelvis without and with contrast	3		☢☢☢☢
X-ray contrast enema	2		☢☢☢☢
Tc-99m WBC scan abdomen and pelvis	2		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

Introduction/Background

Relatively few comparative imaging studies evaluating right lower quadrant (RLQ) pain are available; most of the literature centers on the diagnosis of acute appendicitis (AA), the most common cause of acute RLQ pain requiring surgery. For this reason, the focus of this narrative is on appendicitis and the accuracy of imaging procedures in diagnosing appendicitis, although consideration of other diseases is included.

In a few patients with AA, such as young men, imaging may not be necessary because the clinical presentation is sufficiently diagnostic to allow surgery. Clinical prediction scores, such as the Alvarado score, have been used as a prediction rule for identifying patients with appendicitis; however, their accuracy is inferior to imaging and insufficient as a sole method for appendicitis evaluation. In many published studies for appendicitis imaging, subjects with definitive clinical examination findings of appendicitis undergo operation without imaging. In the reported imaging studies, approximately 40% of imaged subjects on average had appendicitis and, in approximately 30% of subjects, another cause for RLQ pain was identified by imaging. Data on the overall effect of imaging on surgical treatment of appendicitis and patient outcome remain somewhat controversial, but growing evidence supports imaging use to reduce the negative appendectomy rate (NAR).

Computed Tomography and Ultrasound

Computed tomography (CT) is the most accurate examination for evaluating patients without a clear clinical diagnosis of AA. In a meta-analysis of 6 prospective studies through February 2006 of the accuracy of CT and ultrasound (US) in adolescents and adults, CT demonstrated superior sensitivity (91%; 95% confidence interval [CI], 84%–95%) and specificity (90%; 95% CI, 85%–94%) versus US (sensitivity, 78%; 95% CI, 67%–86%; specificity 83%, 95% CI, 76%–88%). The results of CT investigations were consistent across all studies and institutions, whereas US investigations demonstrated heterogeneity, suggesting greater dependence on operator skill. The routine use of CT to evaluate for appendicitis has been shown to decrease overall costs by $447 to $1,412 per patient. CT has been shown to decrease NAR from 16.7% to 8.6% in a meta-analysis of 20 studies with a broad range of 5,616 patients and from 42.9% to 7.1% among 399 women aged 18 to 45 years at a single institution. Accuracy of clinical diagnosis of the etiology of RLQ pain in women of childbearing age tends to be less accurate compared with adult men, thereby suggesting a lower threshold for imaging in this population. In elderly patients with RLQ pain, the accuracy of clinical diagnosis also tends to be less accurate, and the increased risk of complications with AA in this population suggests a lower threshold for imaging with CT, as it has been shown to be highly accurate in depicting AA and its complications.

With the increased use of CT to evaluate for AA, concern has also increased about the effects of radiation exposure from CT, particularly since the majority of the population undergoing imaging for suspected AA is young or relatively young. A few studies have used algorithms with US as a first test to decrease the use of CT or have studied the use of CT with techniques that reduce the radiation dose while maintaining diagnostic accuracy. In 2 recent studies from Europe, diagnostic pathways used US as the primary modality after clinical evaluation by a surgeon. CT was reserved for cases where US was inconclusive or negative. These studies showed pathway sensitivity and specificity of 95.0% and 86.7% with CT used in only 17.9% of cases, and 100% and 86% with CT used in 39.7% of cases; all diagnostic errors in both studies were made in patients who underwent US only. Another European study of 183 patients first used an algorithm of US followed by low-dose (LD) CT when US was inconclusive, and then standard-dose (SD) CT when LDCT was inconclusive; 98.8% sensitivity and 96.9% specificity for diagnosing appendicitis were obtained with a 64% reduction in estimated dose compared to performing SDCT in all imaged patients. A recent study comparing NAR between a SDCT (447 patients) and a LDCT technique (444 patients) in a routine university hospital emergency department (ED) showed no significant difference in NAR with the LD protocol using less than 25% of the estimated dose of the SDCT protocol. In both studies, thin slices and multiplanar reformats were used to aid in diagnosis, which have also been shown in small studies to increase confidence in identifying the appendix.

When using CT, questions remain whether to use intravenous (IV) contrast, enteric contrast, both, or neither in the evaluation for AA. High

accuracy has been reported for techniques using IV contrast as well as for those not using IV contrast (with or without enteric contrast), but few direct comparisons suggest higher accuracy when IV contrast is used. A prospective study with 232 patients showed that non–contrast-enhanced CT (sensitivity, 90%; specificity, 86%) was inferior to rectal-only contrast (sensitivity, 93%; specificity, 95%) and IV and oral contrast (sensitivity, 100%; specificity, 89%). In lieu of individual patient contraindications to IV contrast, its use is recommended in evaluation of RLQ pain. However, if IV contrast is contraindicated, non–contrast-enhanced CT has been shown in 1 study of 300 patients to have a sensitivity of 96%, specificity of 99%, and accuracy of 97% and in a meta-analysis of 7 studies with 1,060 patients to have a summary sensitivity of 92.7% (95% CI, 89.5%–95.0%) and specificity of 96.1% (95% CI, 94.2%–97.5%).

The need for oral contrast when imaging suspected AA with CT, and particularly the need for rectal contrast, is less clear. In 1 prospective study, the use of rectal contrast has been shown to decrease ED stay by greater than 1 hour compared to oral contrast, without a significant difference in patient satisfaction or discomfort. There is concern, however, that rectal contrast can be complicated by bowel perforation, with a cited number similar to barium enema of 0.04%. One recent study showed similar sensitivity and specificity for detection of AA on 64-row multidetector CT (MDCT) with or without oral contrast performed with IV contrast. Another recent study on 16-row MDCT showed no statistical difference either in sensitivity or specificity for detection of AA with or without oral contrast performed with IV contrast, and ED disposition was faster in the IV contrast only group. In both of these studies, for the diagnosis of AA, sensitivity was 100%, and specificity was greater than 97% in the IV contrast only groups. Another recent prospective study randomized patients to ingest or not ingest oral contrast; both groups then underwent IV unenhanced and enhanced standard dose MDCT with each study also using a simulated LD technique. The study determined that diagnostic correctness was more influenced by the reader than by the use of contrast medium or the LD technique. With data from these and other studies, and the increased examination time, problems with patient tolerance, and potential increased radiation exposure from CT in patients with high-density enteric contrast, evidence is trending against the routine use of oral contrast, and particularly against the routine use of rectal contrast, for CT when IV contrast is used.

CT appears superior to US in identifying complications and in evaluating patients with periappendiceal abscess, especially when the abscesses become large. CT results can be used to select therapeutic options other than immediate surgery, including antibiotic treatment with small abscesses and percutaneous drainage with well-defined or small, poorly defined abscesses. Imaging-guided percutaneous drainage combined with antibiotics has been shown to be an effective initial treatment for AA complicated by perforation and abscess, followed by subsequent elective appendectomy or, in selected cases, conservative management. High technical and clinical success rates have been shown with extraluminal appendicolith and large, poorly defined abscesses associated with repeat drainage and clinical failure in a recent study.

CT and US are effective in depicting alternative diagnoses for RLQ pain. In a large single-center study evaluating the diagnostic performance of MDCT for suspected AA, a cause of pain other than AA was established or suggested in a larger number of cases than AA (896 versus 675 in 2,871 patients). The range of diseases studied includes inflammatory bowel disease, infectious bowel disease, small-bowel obstruction, gynecological conditions, genitourinary conditions, and epiploic appendage, omental, and mesenteric inflammation.

Magnetic Resonance Imaging

At this time, few studies evaluate the value of magnetic resonance imaging (MRI) in the general population for AA. MRI is desirable due to its lack of ionizing radiation; however, its relative limitations include greater cost, longer acquisition time, and lesser clinical availability. A meta-analysis of 8 studies (5 retrospective) evaluating MRI for the diagnosis of AA in adults, mostly pregnant women, showed a summary sensitivity of 97% (95% CI, 92%–99%) and specificity of 95% (95% CI, 94%–99%). Since that meta-analysis a prospective study of 138 patients exhibited a sensitivity of 100% and specificity of 99% for MRI, but another prospective study with only 52 patients exhibited a sensitivity of 85% and specificity of 97%. It is anticipated that as MRI becomes more clinically available in the ED setting, the value of MRI for RLQ pain will be further elucidated.

Pediatric Patients

As in adults, appendicitis scoring systems have been inadequate as a single method for appendicitis evaluation and have been inferior to imaging. Relatively, CT and US have been less well evaluated in children than in adults, but there are increasing data on imaging use in the pediatric population. Several factors are unique in children, including increased radiosensitivity to ionizing radiation, smaller body size, and less body fat, which favors initial use of US. A systematic literature review in July 2004 revealed 8 prospective evaluations of US for appendicitis in children. The pooled sensitivity of graded-compression US was 91% (95% CI, 89%–93%), and the specificity was 97% (95% CI, 95%–99%). A meta-analysis published in October 2006 included 26 studies (15 prospective) of US and CT in the pediatric population. The pooled sensitivity of US was 88% (95% CI, 86%–90%) and specificity of 94% (95% CI, 92%–95%) compared with CT, which exhibited a pooled sensitivity of 94% (95% CI, 92%–97%) and specificity of 95% (95% CI, 94%–97%) [49]. These results suggest that although CT is more accurate, US is nearly as good in experienced hands and, given the lack of ionizing radiation, is the preferred modality in children, particularly if equivocal results are followed up by CT. Thus the approach of CT after US appears to have excellent accuracy, with reported sensitivity and specificity of 94% in a small study and sensitivity of 98.6% and specificity of 90.6% in a larger study. A single retrospective study showed that in intermediate-to-high pretest probability children, US followed by CT is most cost-effective, whereas in low pretest probability patients, US alone is the most effective

and least costly strategy.

A recent retrospective study examining practices at 40 pediatric hospitals between 2005 and 2009 reported a trend toward increasing use of US and decreasing use of CT, though in 2009 CT was still used more commonly in the ED than US (29.2% versus 24.5%, respectively). Using these same data, it was also observed that imaging in boys older than age 5 did not lower the NAR significantly, and therefore imaging in this group may be reserved safely for those with concern for complications or changes in surgical management. If CT is performed, IV contrast is recommended; however, enteric contrast (oral or rectal contrast) has not been shown to increase sensitivity significantly in children, and it has been suggested that routine enteric contrast use be phased out though there have not been larger, multisite trials related to this suggestion. Addition of multiplanar reformats, particularly coronal images, has been shown in a small study to increase reader confidence in identifying the appendix in its entirety and other periappendiceal findings and should be included in the CT protocol. Recently, nonvisualization of the appendix on a normal CT has been shown to have a high negative predictive value of 98.7% (95% CI, 95.5%–99.8%).

Investigation of MRI as a viable option to evaluate for AA has increased as MRI has been used more often in pediatric patients and has become more available in the ED setting of pediatric hospitals. One small prospective study of 42 patients receiving MRI without sedation or exogenous contrast administration, as an adjunct to CT or US, achieved 100% sensitivity in 12 cases of appendicitis. In a larger prospective study of 208 pediatric patients suspected of having AA who underwent MRI without sedation or exogenous contrast administration a sensitivity of 97.6% (95% CI, 87.1%–99.9%) and specificity of 97% (95% CI, 93.2%–99%) was achieved with 40 cases of AA. With lack of widespread experience and issues of cost, availability, and the potential need for sedation, the use of MRI for suspected AA in pediatric patients is currently limited to specialized pediatric hospitals.

Pregnant Patients

Evaluation of the accuracy of imaging in pregnant women has received more attention in the literature in recent years. In general, ionizing radiation from CT should be avoided during pregnancy. US is clearly a safer imaging option and is the first imaging test of choice, although CT after equivocal US has been validated for diagnosis. A systematic literature review through August 2008 addressed 8 retrospective studies of CT and MRI after negative or inconclusive US in pregnant women. The pooled sensitivity of CT after US was 86% (95% CI, 64%–97%), and the specificity was 97% (95% CI, 86%–100%). MRI is the preferred test after inconclusive US, as new studies have shown a comparable sensitivity and specificity with CT without exposing the fetus to ionizing radiation. The pooled sensitivity of MRI after US was 80% (95% CI, 44%–98%), and the specificity was 99% (95% CI, 94%–100%). A more recent meta-analysis of 5 case series evaluating MRI for AA in pregnancy yielded a sensitivity of 90.5%, specificity of 98.6%, positive predictive value (PPV) of 90.4%, and negative predictive value (NPV) of 99.5%, with the appendix visualized in 92.1% of cases. These data support an algorithm of US followed by MRI if the initial US is inconclusive, which is frequently the case as shown in the largest case series where the detection of a normal appendix in pregnant patients by US was 2%, but was 87% by MRI.

Abdominal and Pelvic Radiography

Radiography is of limited value for diagnosing AA except in occasional circumstances when an appendicolith or other ancillary findings are identified. Although barium enema has been used historically to diagnose appendicitis, its use depends on the negative finding of nonvisualization of the appendix and may be quite uncomfortable in patients with AA. Nonetheless, barium small-bowel follow-through or barium enema may be useful following cross-sectional imaging studies for other causes of RLQ pain, including suspected small-bowel obstruction, infectious ileitis, and inflammatory bowel disease (see the National Guideline Clearinghouse [NGC] summary ACR Appropriateness Criteria® suspected small-bowel obstruction).

Nuclear Medicine

Nuclear medicine imaging has also been reported for evaluating RLQ pain. However, the sensitivity and specificity of nuclear scans for this indication have been shown to be significantly inferior to US, CT, and MRI.

Summary

- Appendicitis may be diagnosed clinically; however, imaging increases sensitivity and specificity for diagnosis.
- In general, CT is the most accurate imaging study for evaluating suspected appendicitis and alternative etiologies of RLQ abdominal pain. Data favor the use of IV contrast for CT, but the need for enteric contrast when IV contrast is used is not favored.
- Dose-reduction strategies in CT must be employed following the As Low As Reasonably Achievable principle. Minimizing radiation dose in CT while maintaining diagnostic accuracy is an area of active investigation.
- In children, US is the preferred initial examination as it is nearly as accurate as CT for diagnosis of appendicitis but is without ionizing radiation exposure.
- In pregnant women, data support the use of MRI after equivocal or inconclusive US.

Safety Considerations in Pregnant Patients

Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

- ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation
- ACR-ACOG-AIUM Practice Guideline for the Performance of Obstetrical Ultrasound
- ACR Manual on Contrast Media
- ACR Guidance Document for Safe MR Practices

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 mL/min/1.73 m^2), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73 m^2. For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

Abbreviations

- CT, computed tomography
- MRI, magnetic resonance imaging
- Tc, technetium
- US, ultrasound
- WBC, white blood cell

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".		

Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

Scope

Disease/Condition(s)

Right lower quadrant pain and suspected appendicitis

Guideline Category

Diagnosis

Evaluation

Clinical Specialty

Emergency Medicine

Family Practice

Gastroenterology

Internal Medicine

Nuclear Medicine

Pediatrics

Radiology

Surgery

Intended Users

Health Plans

Hospitals

Managed Care Organizations

Physicians

Utilization Management

Guideline Objective(s)

To evaluate the appropriateness of initial radiologic examinations for patients with right lower quadrant pain and suspected appendicitis

Target Population

Patients with right lower quadrant pain and suspected appendicitis

Interventions and Practices Considered

1. X-ray
    - Abdomen
    - Contrast enema
2. Ultrasound (US)
    - Abdomen
    - Pelvis
3. Computed tomography (CT) abdomen and pelvis

    - Without contrast
    - With contrast
    - Without and with contrast
4. Magnetic resonance imaging (MRI) abdomen and pelvis
    - Without and with contrast
    - Without contrast
5. Technetium (Tc)-99m white blood cell (WBC) scan abdomen and pelvis

Major Outcomes Considered

Utility of radiologic examinations in differential diagnosis

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Literature Search Procedure

Staff will search in PubMed only for peer reviewed medical literature for routine searches. Any article or guideline may be used by the author in the narrative but those materials may have been identified outside of the routine literature search process.

The Medline literature search is based on keywords provided by the topic author. The two general classes of keywords are those related to the condition (e.g., ankle pain, fever) and those that describe the diagnostic or therapeutic intervention of interest (e.g., mammography, MRI).

The search terms and parameters are manipulated to produce the most relevant, current evidence to address the American College of Radiology Appropriateness Criteria (ACR AC) topic being reviewed or developed. Combining the clinical conditions and diagnostic modalities or therapeutic procedures narrows the search to be relevant to the topic. Exploding the term "diagnostic imaging" captures relevant results for diagnostic topics.

The following criteria/limits are used in the searches.

1. Articles that have abstracts available and are concerned with humans.
2. Restrict the search to the year prior to the last topic update or in some cases the author of the topic may specify which year range to use in the search. For new topics, the year range is restricted to the last 10 years unless the topic author provides other instructions.
3. May restrict the search to Adults only or Pediatrics only.
4. Articles consisting of only summaries or case reports are often excluded from final results.

The search strategy may be revised to improve the output as needed.

Number of Source Documents

The total number of source documents identified as the result of the literature search is not known.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Strength of Evidence Key

Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis and results.

Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.

Category 3 - The conclusions of the study may be valid but the evidence supporting the conclusions is inconclusive or equivocal.

Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The topic author drafts or revises the narrative text summarizing the evidence found in the literature. American College of Radiology (ACR) staff draft an evidence table based on the analysis of the selected literature. These tables rate the strength of the evidence (study quality) for each article included in the narrative text.

The expert panel reviews the narrative text, evidence table, and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the table. Each individual panel member assigns a rating based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see the "Availability of Companion Documents" field).

Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

Rating Appropriateness

The appropriateness ratings for each of the procedures included in the Appropriateness Criteria topics are determined using a modified Delphi methodology. A series of surveys are conducted to elicit each panelist's expert interpretation of the evidence, based on the available data, regarding the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. American College of Radiology (ACR) staff distribute surveys to the panelists along with the evidence table and narrative. Each panelist interprets the available evidence and rates each procedure. The surveys are completed by panelists without consulting other panelists. The appropriateness rating scale is an ordinal scale that uses integers from 1 to 9 grouped into three categories: 1, 2, or 3 are in the category "usually not appropriate"; 4, 5, or 6 are in the category "may be appropriate"; and 7, 8, or 9 are in the category "usually appropriate." Each panel member assigns one rating for each procedure for a clinical scenario. The ratings assigned by each panel member are presented in a table displaying the frequency distribution of the ratings without identifying which members provided any particular rating.

If consensus is reached, the median rating is assigned as the panel's final recommendation/rating. Consensus is defined as eighty percent (80%) agreement within a rating category. A maximum of three rounds may be conducted to reach consensus. Consensus among the panel members must be achieved to determine the final rating for each procedure.

If consensus is not reached, the panel is convened by conference call. The strengths and weaknesses of each imaging procedure that has not reached consensus are discussed and a final rating is proposed. If the panelists on the call agree, the rating is proposed as the panel's consensus. The document is circulated to all the panelists to make the final determination. If consensus cannot be reached on the call or when the document is circulated, "No consensus" appears in the rating column and the reasons for this decision are added to the comment sections.

This modified Delphi method enables each panelist to express individual interpretations of the evidence and his or her expert opinion without excessive influence from fellow panelists in a simple, standardized and economical process. A more detailed explanation of the complete process can be found in additional methodology documents found on the ACR Web site (see also the "Availability of Companion Documents" field).

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

- The routine use of computed tomography (CT) to evaluate for appendicitis has been shown to decrease overall costs by $447 to $1,412 per patient.
- A single retrospective study showed that in intermediate-to-high pretest probability children, ultrasound (US) followed by CT is most cost-effective, whereas in low pretest probability patients, US alone is the most effective and least costly strategy.

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current literature and expert panel consensus.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Selection of appropriate radiologic imaging procedures for evaluation of patients with acute right lower quadrant pain and suspected appendicitis

Potential Harms

Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk.

Gadolinium-based Contrast Agents

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 mL/min/1.73 m^2), and almost never in other patients. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73 m^2. For more information, please see the American College of Radiology

(ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

Relative Radiation Level

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document (see the "Availability of Companion Documents" field).

Qualifying Statements

Qualifying Statements

The American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Patient-centeredness

Identifying Information and Availability

Bibliographic Source(s)

Smith MP, Katz DS, Rosen MP, Lalani T, Carucci LR, Cash BD, Kim DH, Piorkowski RJ, Small WC, Spottswood SE, Tulchinsky M, Yaghmai V, Yee J, Expert Panel on Gastrointestinal Imaging. ACR Appropriateness CriteriaÂ® right lower quadrant pain--suspected appendicitis. [online publication]. Reston (VA): American College of Radiology (ACR); 2013. 10 p. [74 references]

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

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Guideline Developer(s)

American College of Radiology - Medical Specialty Society

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Guideline Committee

Committee on Appropriateness Criteria, Expert Panel on Gastrointestinal Imaging

Composition of Group That Authored the Guideline

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Financial Disclosures/Conflicts of Interest

Not stated

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Rosen MP, Ding A, Blake MA, Baker ME, Cash BD, Fidler JL, Grant TH, Greene FL, Jones B, Katz DS, Lalani T, Miller FH, Small WC, Spottswood S, Sudakoff GS, Tulchinsky M, Warshauer DM, Yee J, Coley BD, Expert Panel on Gastrointestinal Imaging. ACR Appropriateness Criteria® right lower quadrant pain -- suspected appendicitis. [online publication]. Reston (VA): American College of Radiology (ACR); 2010. 7 p.

Guideline Availability

Electronic copies: Available from the American College of Radiology (ACR) Web site .

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2013 Nov. 3 p. Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.
- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 2013 Apr. 1 p. Electronic copies: Available in Portable Document Format (PDF) from the ACR Web site.
- ACR Appropriateness Criteria®. Evidence table development – diagnostic studies. Reston (VA): American College of Radiology; 2013 Nov. 3 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2013 Nov. 2 p. Electronic copies: Available in Portable Document Format (PDF) from the ACR Web site.
- ACR Appropriateness Criteria®. Manual on contrast media. Reston (VA): American College of Radiology; 90 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 2013 Apr. 1 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria® right lower quadrant pain—suspected appendicitis. Evidence table. Reston (VA): American College of Radiology; 2013. 21 p. Electronic copies: Available from the ACR Web site.

Patient Resources

None available

NGC Status

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